



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

Solar Energy Grid Integration Systems “SEGIS” Overview

for the

International Photovoltaic Reliability Workshop (IPRW) II

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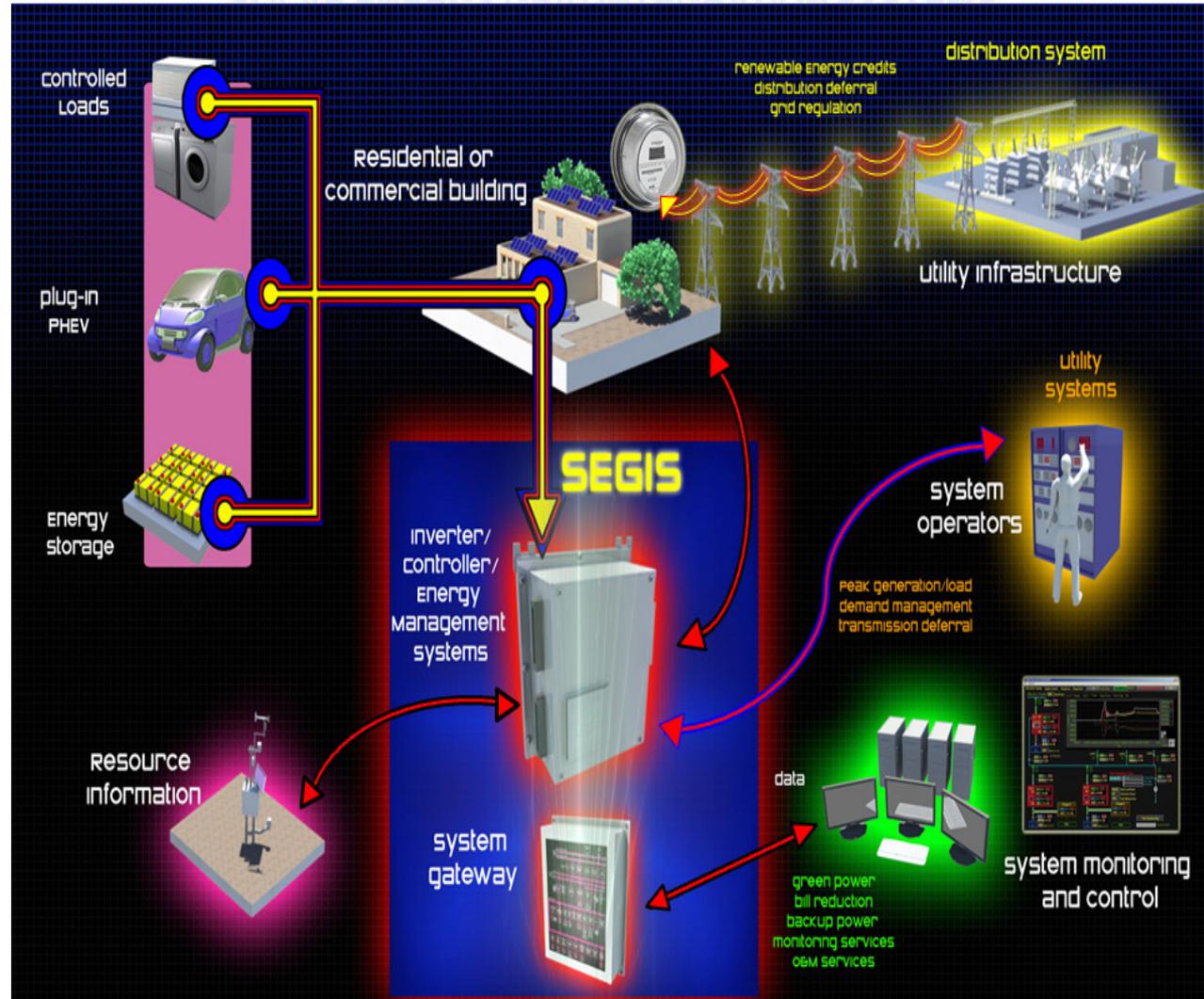




This Program Overview Presents

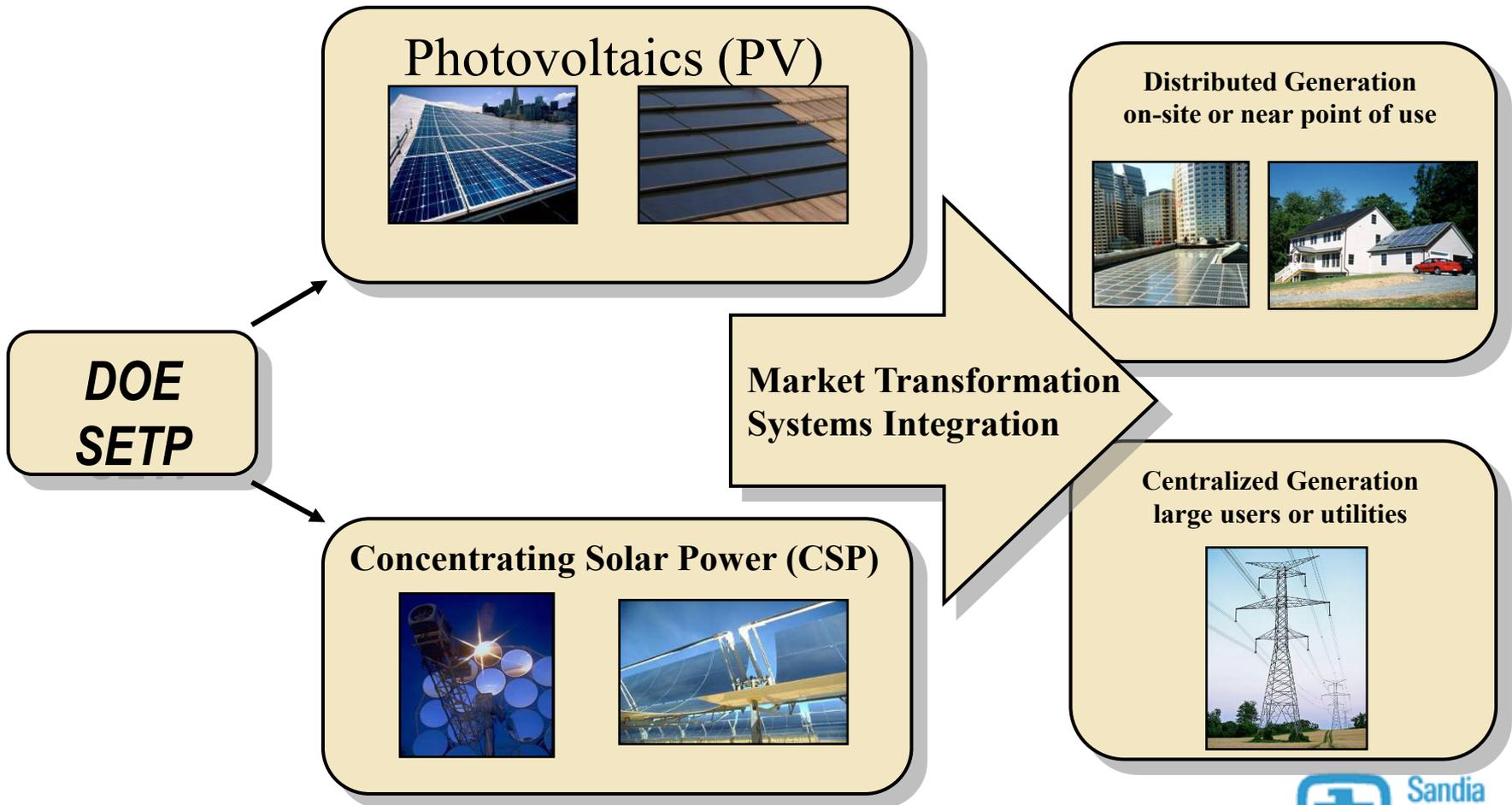
-  **The Mission of the DOE Solar Program**
-  **The Goals of the SEGIS Project and Solicitation**
-  **The Stages/ Timetable of the Projects**
-  **The Contractor Information**
-  **Future Directions and Impacts**

SOLAR ENERGY GRID INTEGRATION SYSTEMS





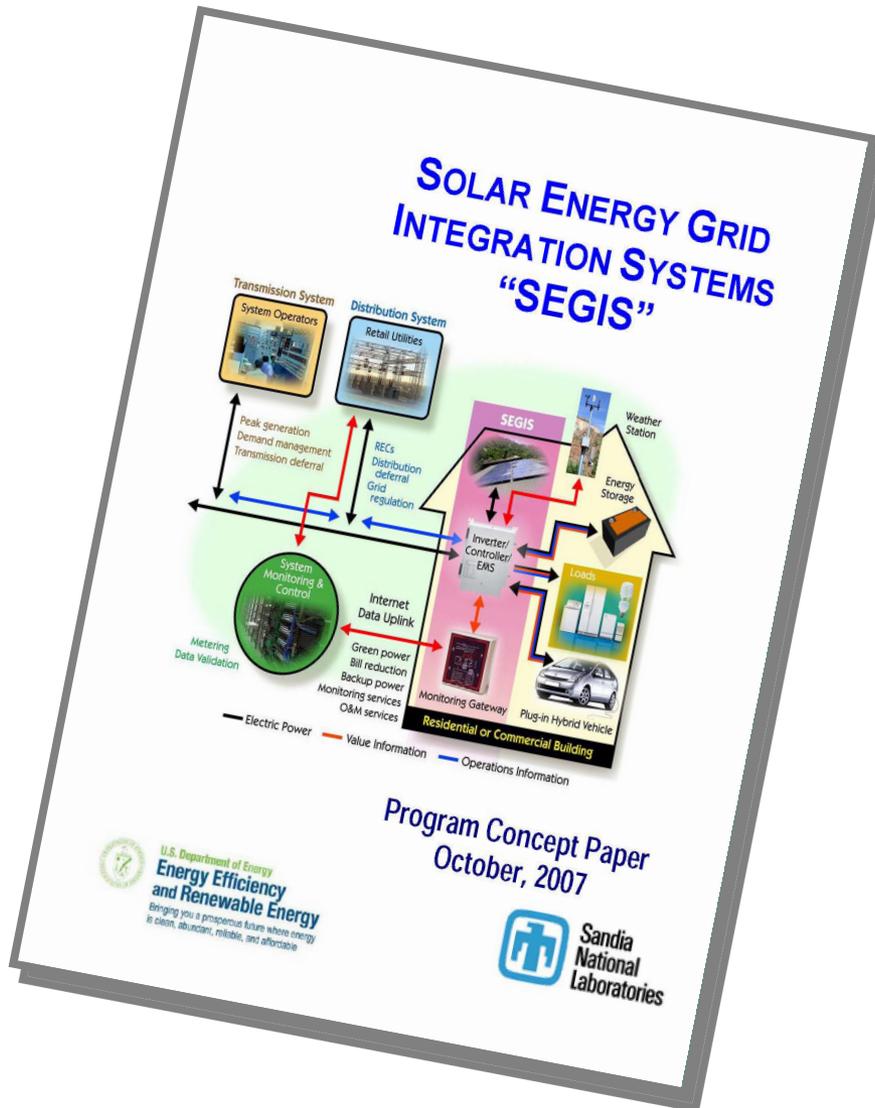
“Accelerate” the wide-spread adoption of solar electric technologies across the United States





The Concept Paper

- ❑ Captured the result of 3 industry workshops that identified and prioritized technical issues related to high penetration PV
- ❑ Described the goals and requirements of the SEGIS program
- ❑ Conveyed detailed program requirements to SEGIS solicitation bidders

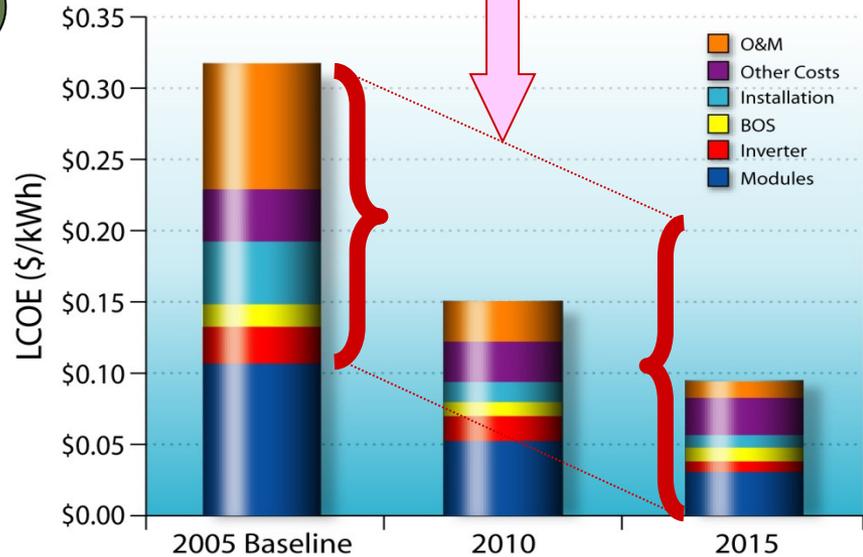




VISION

**ENABLE HIGHLY
 INTEGRATED,
 INNOVATIVE,
 ADVANCED INVERTERS,
 CONTROLLERS,
 CRITICAL BOS
 CONCEPTS &
 ENERGY MANAGEMENT
 FOR RESIDENTIAL
 AND COMMERCIAL
 PV APPLICATIONS**

**All Non-module costs must be reduced.
 Brackets show magnitude of
 improvement needed**



**Without dramatic non-module cost improvements, the goals (\$0.05-\$0.10/kWh by 2015) will not be met even if PV modules are given away!
 SEGIS = "VALUE ADDED"**

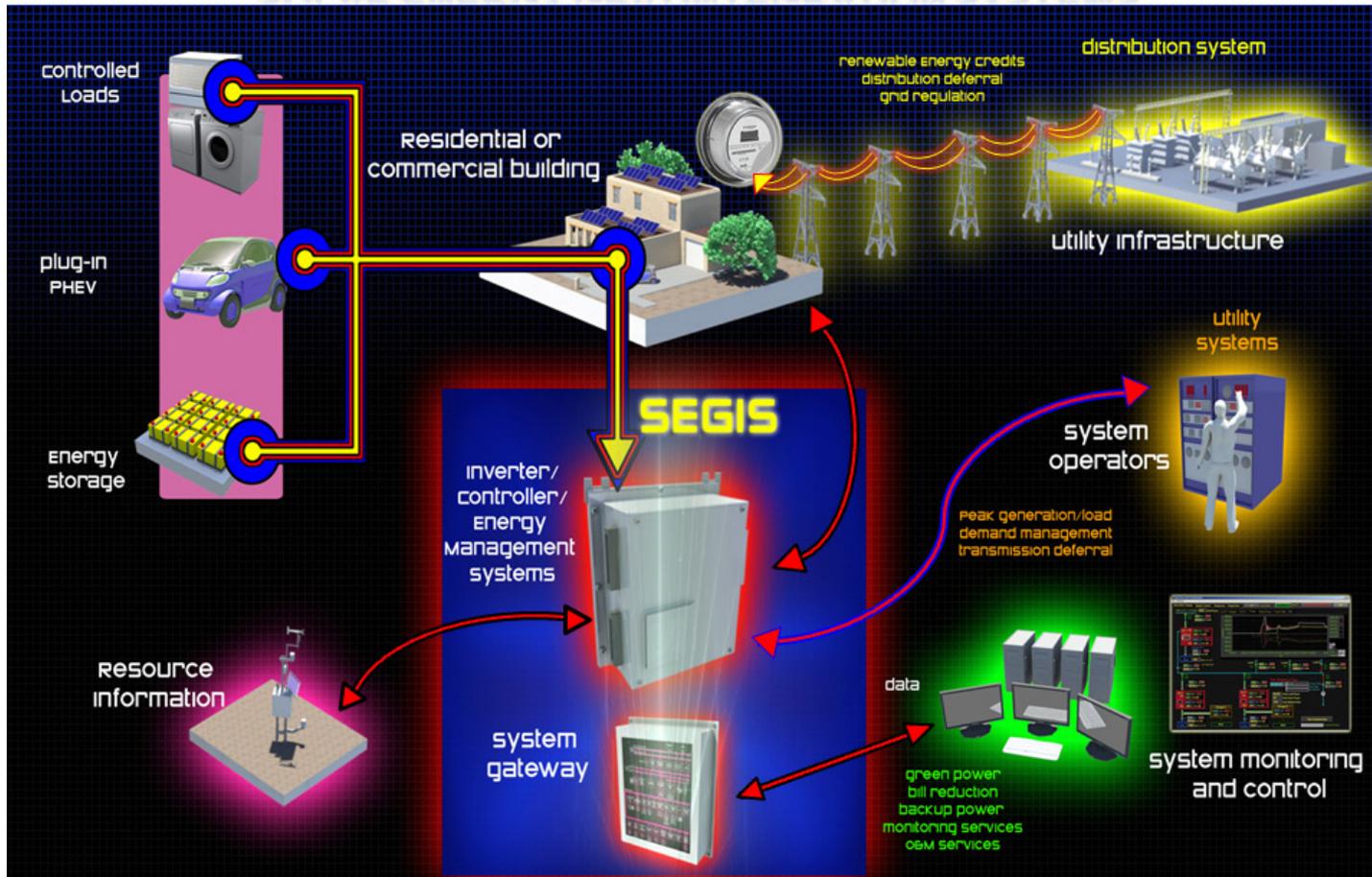
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SEGIS - Solar Energy Grid Integration Systems

SEGIS focus is to develop the intelligent hardware that interconnects PV to the evolving “Smarter” electrical grid

SOLAR ENERGY GRID INTEGRATION SYSTEMS

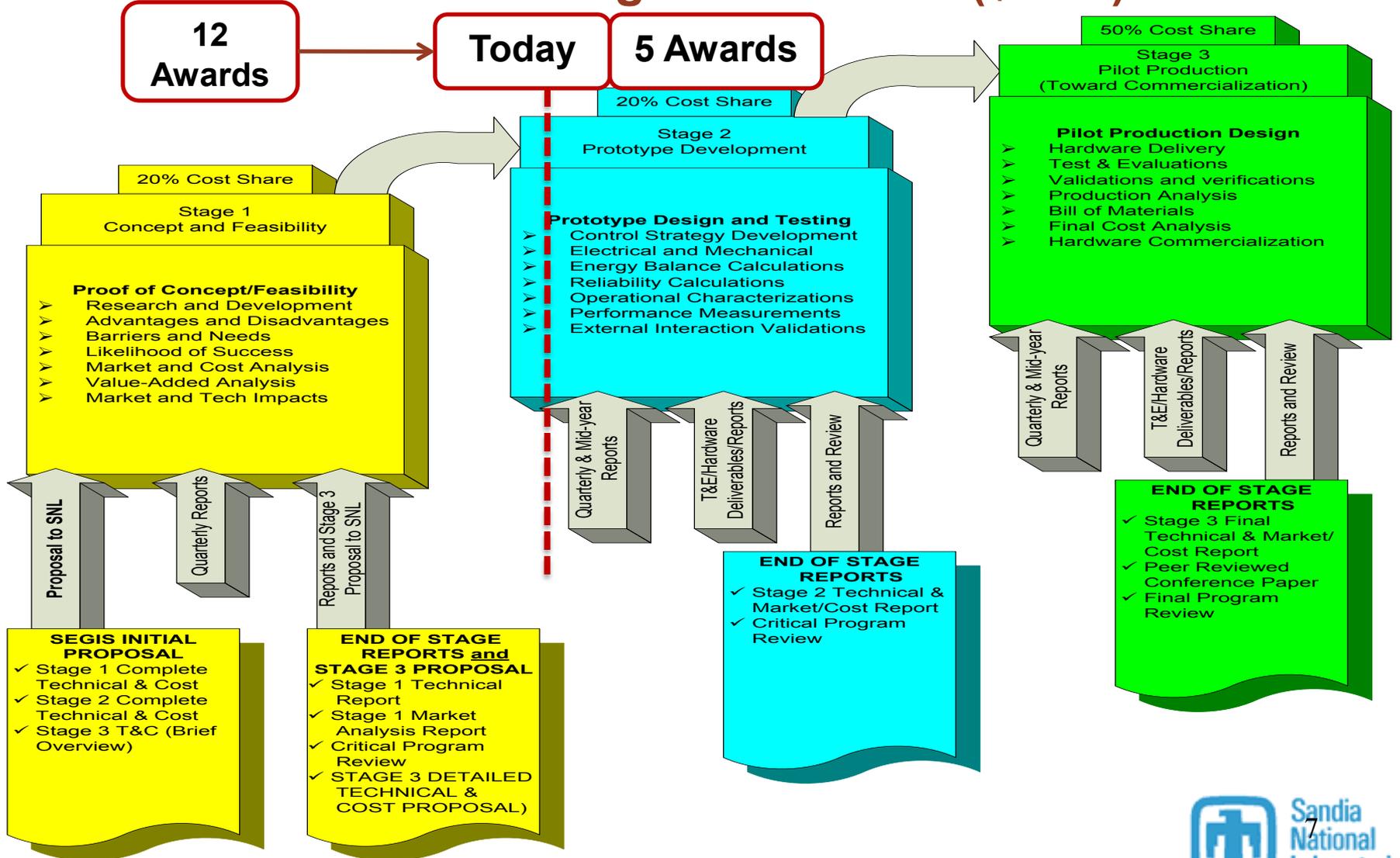


Electric Power █ value information █ operators information █





SEGIS is a 3-Stage Solicitation (\$24M)



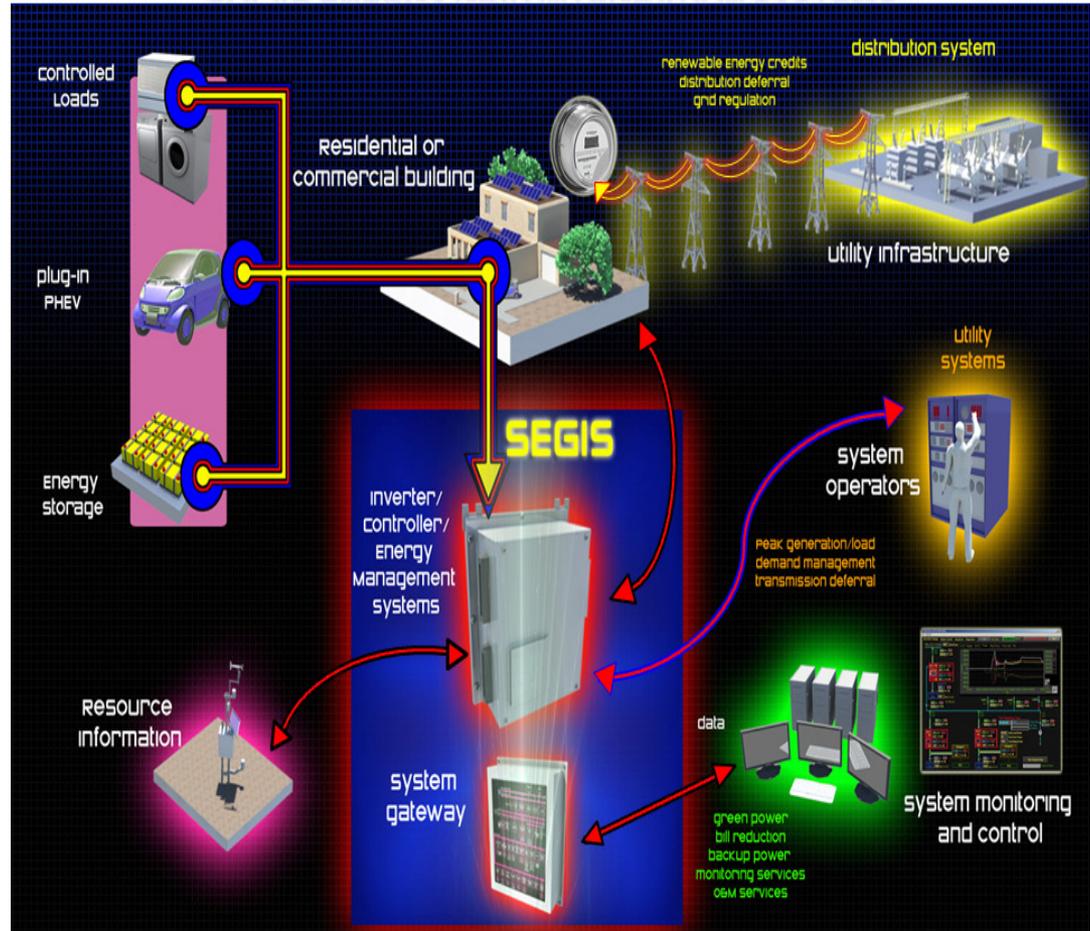


SOLAR ENERGY GRID INTEGRATION SYSTEMS



The Needs

- High PV Penetration
- “Smart Grid” Integration
- High Reliability/Lifetime
- Value Added PV Systems
- Communications
- Performance Optimization
- System Concepts



Electric Power — value information — operators information —



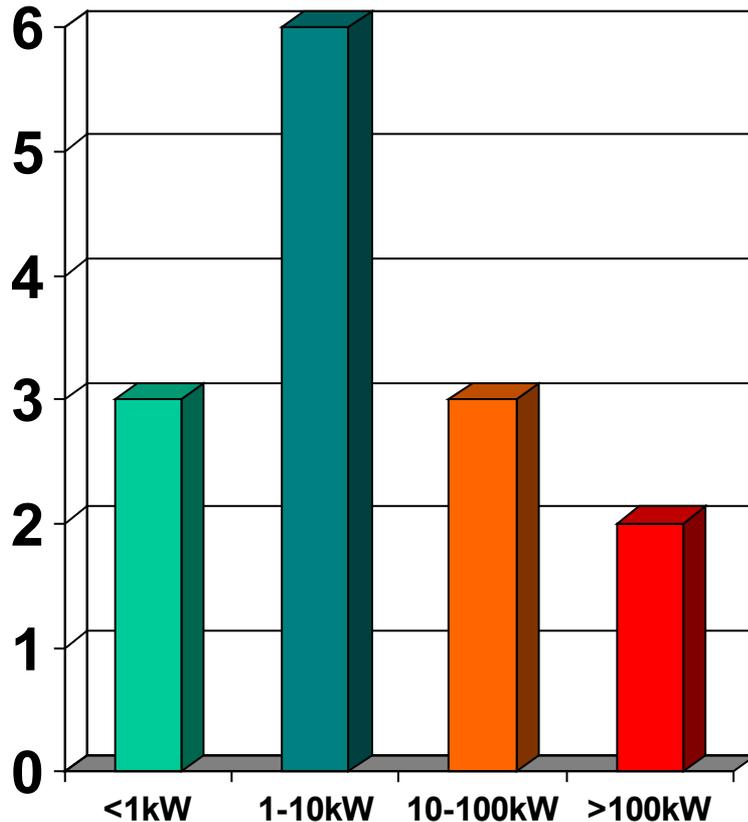
12 awards began in June 2008 for 9-mo proof of concept/feasibility
(avg. \$238K DOE funding per award)

Category	Contractor
Micro-Inverter	Enphase Energy
	Smart Spark (Solar-Bridge)
	Petra Solar
Residential	GE
	Apollo Solar
Commercial	VPT Energy
	PV Powered
Commercial/Integration	Princeton Power
	Premium Power
System Integration	EMTEC
	UCF/FSEC

Proposals in May 2009 for Stage 2 &3 prototypes, testing, commercialization
(avg. \$2.67M DOE funding per award)

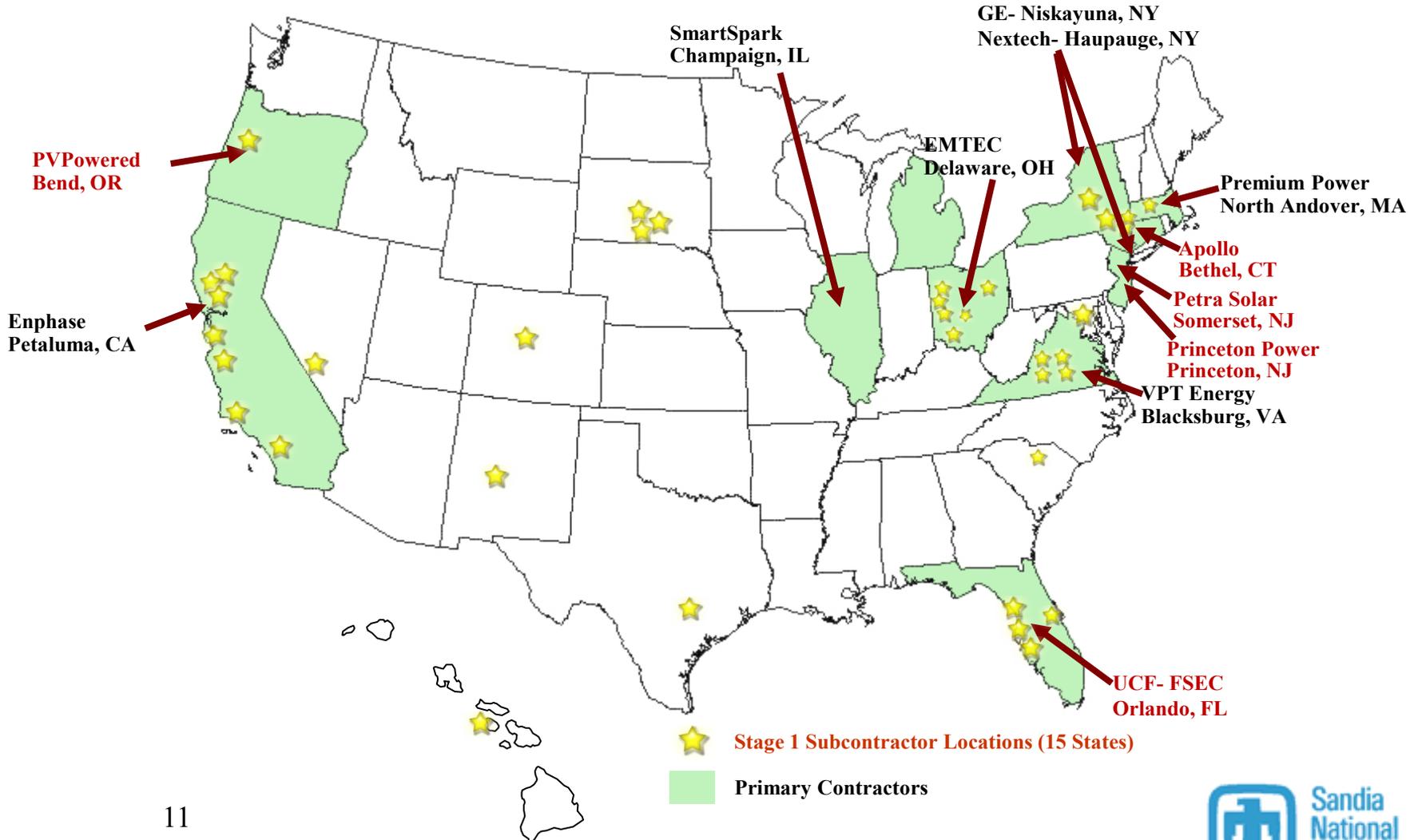


“SEGIS” Contractor’s R&D System Ratings*



- <1kW Represents Micro-inverters
 - All are unique topologies
 - All are Integrated with PV modules
- 1 – 10 kW Represents Residential Systems
- 10 – 100 kW Represents Commercial Systems
- >100 kW Can be Commercial or Utility Systems

*Some contractors proposed multiple developments





All SEGIS Stage 1 Contracts Include:

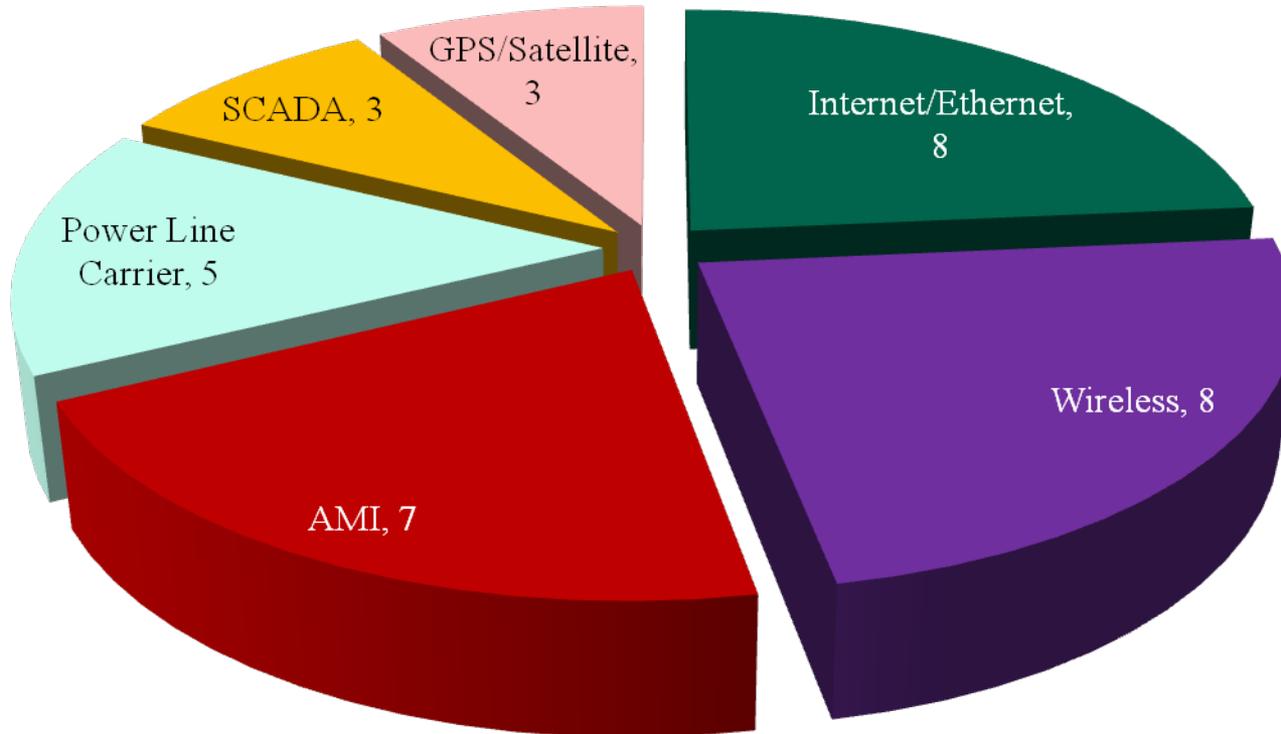
-  Inverter Design
-  Controller Design
-  Energy Management
 -  12 Electrical EMS
 -  9 Building EMS (HVAC etc)
-  Total or Partial System
Integration/Optimization
-  Communications/Comm
Protocols and Methods
-  Utility Support

**NOTE: Several SEGIS
developments will require
changes in interconnect
standards for maximum
interconnect benefits**





Communications Types Studied in Stage 1 (Number of Contractors)



Communications Method Studied Does NOT Mean It Was Selected as a Preferred Method
Numerous Communications Pitfalls and Incompatibilities were Uncovered
Communication Levels from Internal Controls to Utility Interactive Controls
Speed of Response and Communication Reliability Are the Main Issues



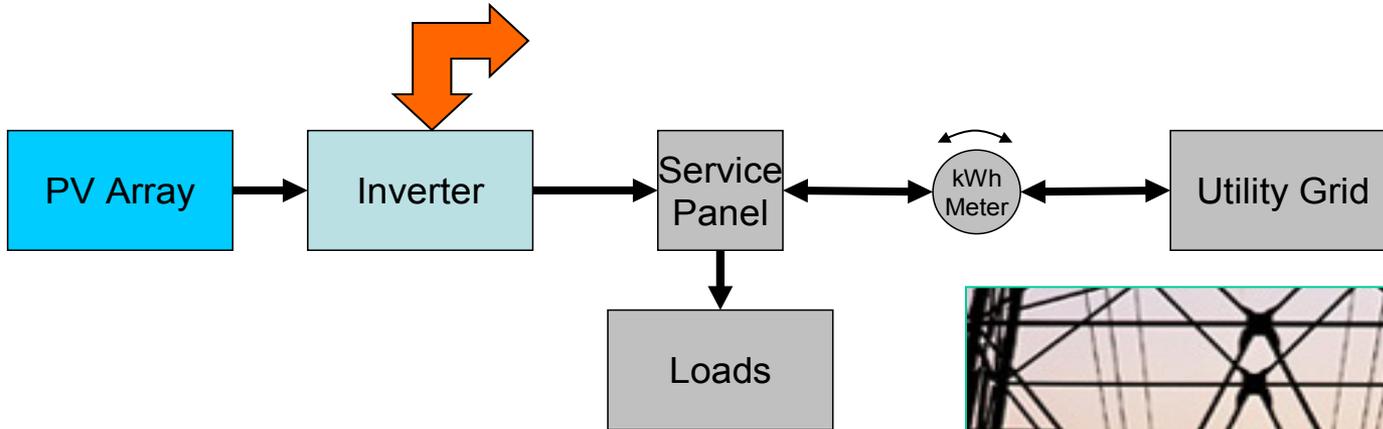
 **SIGNIFICANTLY Advance Inverters, Controllers and Energy Management Systems and the required Communications to maximize PV system value for Utilities and Consumers**

 **Scope**

- PV Systems for High-value Residential and Commercial Applications (100W – 250kW)
- PV Systems using Advanced Energy Management
- Building/Structure PV Systems AND Hybrid/Micro-grid Applications that Utilize Energy Storage
- Does NOT Include Development of PV Cell/Module or Energy Storage Technology.



Today's Typical Utility Interconnection

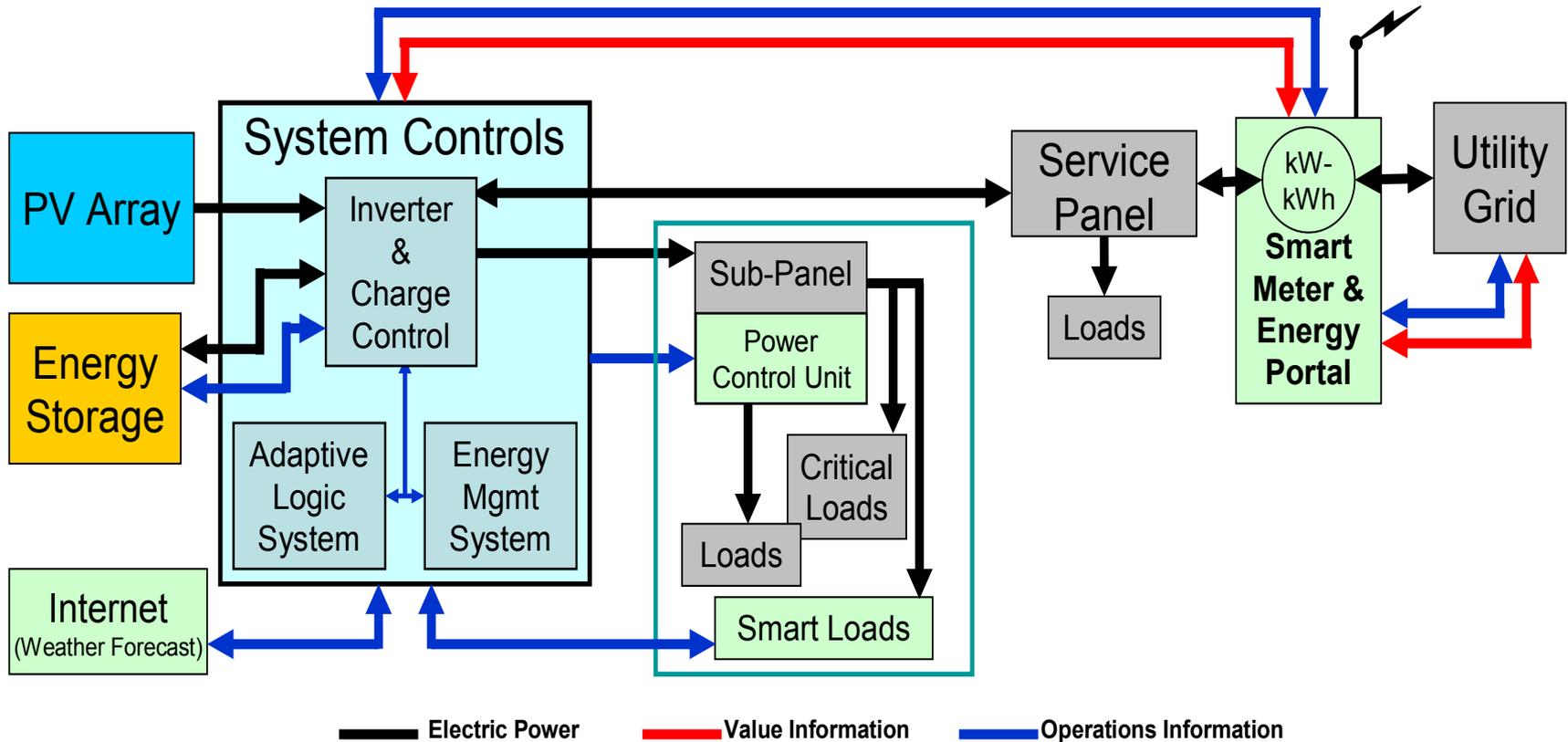


- Anti-islanding**
- AC and DC Voltage Trips**
- Over- & Under- Frequency**
- Power limit**
- Over Temperature**





A Future Conceptual Intelligent PV/Utility Interconnection

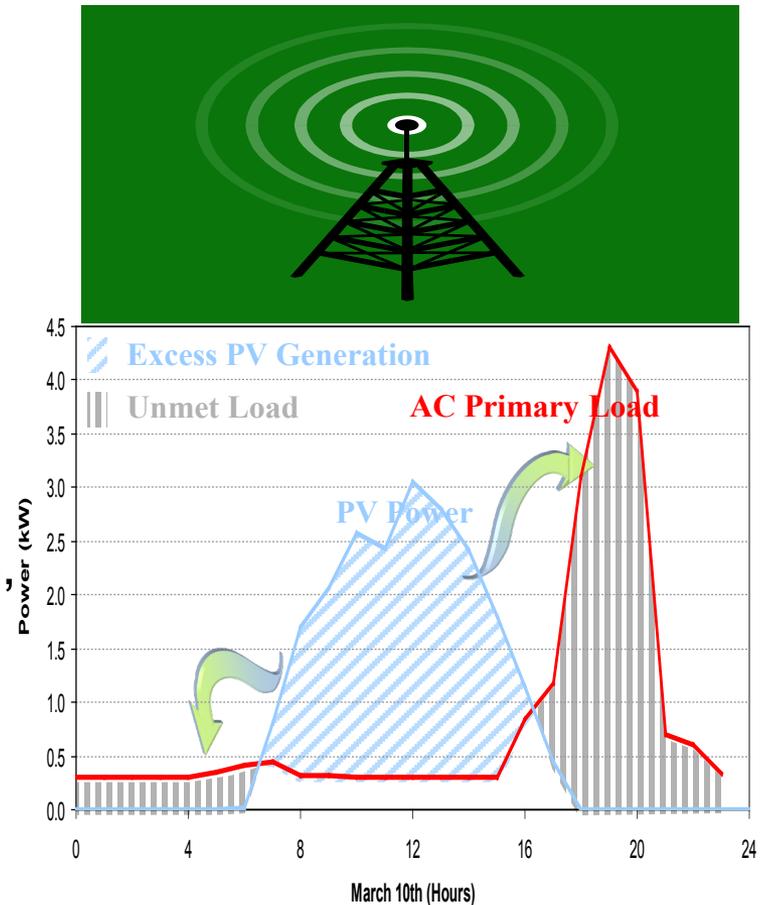




Advanced Communications Applications With “SEGIS”

Energy Management and Communications Methods

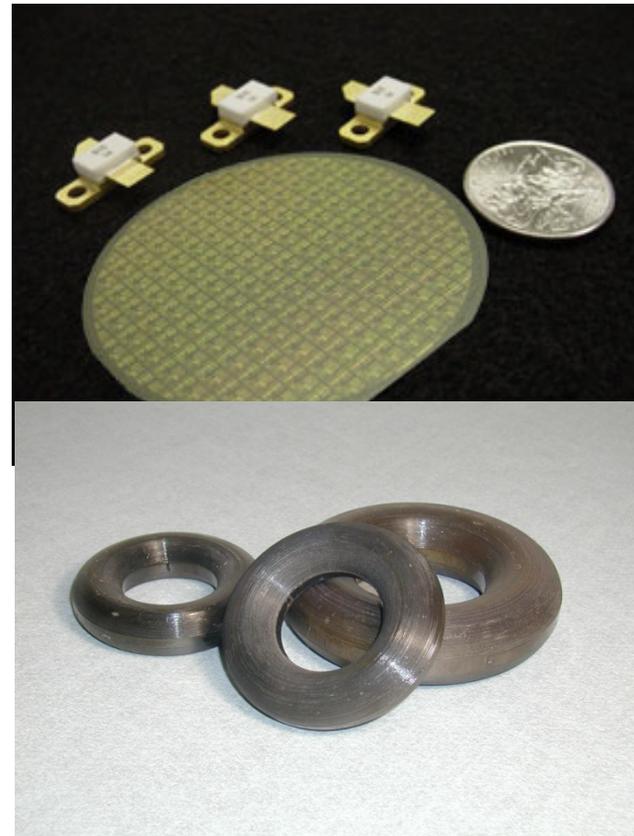
- I/O protocols
- Wireless/PLC/Ethernet
- Value-added Sensors/Detection to Improve Utility Acceptance
- Advanced Communications Devices, Sensors and Methodologies
- INTEGRATION with Storage for Performance Optimization





Advanced Component Applications Through “SEGIS”

-  **Advanced Semiconductor Uses**
-  **Highly-integrated Custom ICs**
-  **Integrated Communication**
-  **Micro-grid Controls & AMI**
-  **MEMs & SiC Applications**
-  **Integrated Cooling/Packages**
-  **Advanced Surge Suppression**
-  **Diagnostics/Gateways**
-  **Interactive Monitoring**
-  **Innovative Packaging**
-  **Internal Protection/Longevity**
-  **Magnetic Materials**
 - Lower cost, higher performing
 - Planar & integrated devices
 - Nano-crystalline materials





-  **Advanced System-Integrated Inverters Controllers and Energy Management Hardware that utilize communications and advanced algorithms and controls for complete system optimization**
-  **Significantly Improved Value and Performance of PV Systems with energy storage options**
-  **More Complex Inverters/controllers, but with higher reliability & lower overall costs**
-  **Further SEGIS advances will enable HIGH PENETRATION of PV Applications using energy storage and/or micro-grid controls and optimization**



-  **SEGIS Developments to be Prototyped in Stage 2 and Commercialized in Stage 3**
-  **Device & System Self Protection/ High Reliability**
 -  *Advanced Adaptive systems with Communications to Optimize PV System Values*
 -  *Hardware and Software advances to protect the inverter and components to provide high reliability/lower LCOE*
 -  *Predictions of System STATUS/HEALTH/LIFETIME*
-  **Improved Inverter AND System Modeling to Facilitate Predictive Advanced Adaptive Controls**
-  **Customer Friendly Layouts and Aesthetics**



- **Apollo Solar of Bethel, CT: with**
 - Saft Batteries (Valdosta, GA),
 - Electric Power Research Institute (EPRI) (Knoxville, TN)
 - California Independent System Operator (Folsom, CA).
- **This project creates innovative inverters utilizing energy storage and two-way communications between solar electrical systems and utilities.**



- **PV Powered of Bend, OR: partnered w/**
 - Portland General Electric (Portland, OR), South Dakota State University (Brookings, SD), Northern Plains Power Technologies (Brookings, SD), Schweitzer Engineering Lab (Pullman, WA), and SENSUS (Raleigh, NC).
- **The project will reinforce the fundamental objectives of the SEGIS program to optimize interconnections across the full range of emerging PV module technologies through innovative systems integration.**



- **Petra Solar of South Plainfield, with**
 - University of Central Florida (Orlando, FL)
 - Fifteen Electric Utilities with service in NJ, PA, OH, DE, MD, DC, FL, TX:
- **This project complements the mission of the Solar Program to achieve widespread adoption of solar energies. It supports improving reliability and resiliency so that high levels of PV integration can be adapted.**



- **Princeton Power of Princeton, NJ: with**
 - Transistor Device Inc (TDI),
 - LaGuardia Community College (New York, NY)
 - Idyllwild Municipal Water District (San Diego, CA)
 - National Oceanographic & Atmospheric Administration (Princeton, NJ)
 - Princeton Plasma Physics Laboratory (Princeton, NJ)
 - Premier Power
 - SPG Solar (Novato, CA)
 - Spire (Bedford, MA).
- **This project focuses on lowering manufacturing costs through integrated controls for energy storage and develops new inverter designs.**



- **Florida Solar Energy Center/UCF: with**
 - Satcon Technology Corporation, (Boston, MA)
 - SENTECH, Inc. (Bethesda, MD)
 - SunEdison (Beltsville, MD)
 - Cooper Power Systems EAS (Minneapolis, MN)
 - Northern Plains Power Technologies (Brookings, SD)
 - Lakeland Electric Utilities (Lakeland, FL)
- **This project focuses on solving technical challenges that must be overcome to include higher PV penetration levels in larger electrical systems.**



Questions & Follow-up:

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Resources:

DOE Solar Energy Technologies Program:

www1.eere.energy.gov/solar/

System Integration:

www1.eere.energy.gov/solar/systems_integration_program.html

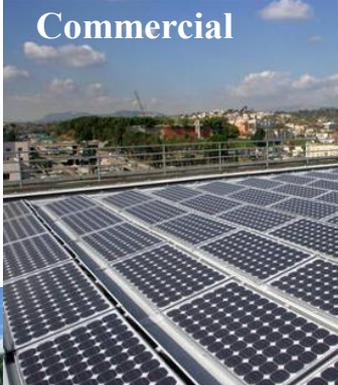
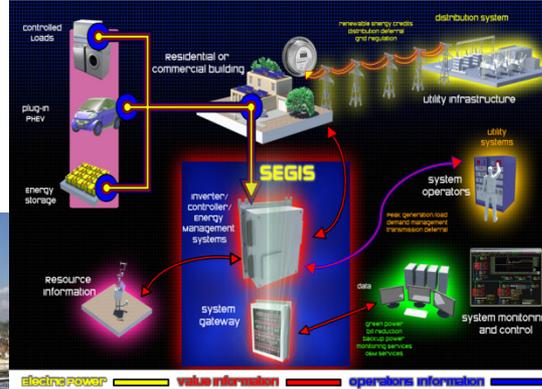
Sign up for Newsletter & Market Analysis: Send email to solar@ee.doe.gov



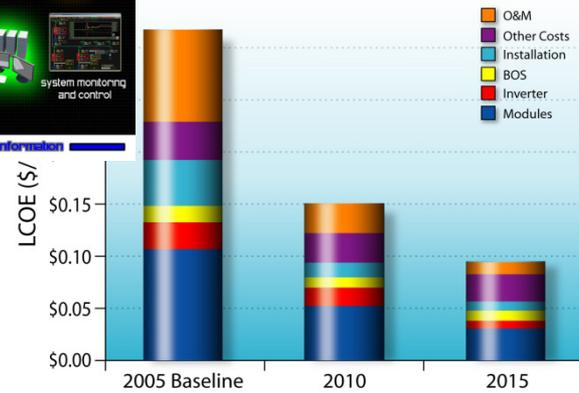
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Commercial



Thank You

References:

http://www1.eere.energy.gov/solar/systems_integration_program.html

<http://www.sandia.gov/solar>

